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1416 DODGE STREET
OMAHA, NEBRASKA 68179

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Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Room 222
Washington, D.C. 20554

December 20, 1994

RE: Ex Parte Presentation in PR Docket No. 2-235

Dear Mr. Secretary:

In accordance with Section 1.1206 of the Commission's Rules, the undersigned hereby notifies the Commission that a written ex parte presentation (copy enclosed) was made to the staff of the Commission's Wireless Telecommunications Bureau (Private Radio Division), on December 20, 1994, in connection with the Commission's pending proceeding concerning spectrum refarming in PR Docket No. 92-235.

Sincerely,

Edwin F. Kemp
Director, Telecom Engineering
Union Pacific Railroad

Enclosure

cc: Kathryn Hosford, FCC
Lynn Andrews, Union Pacific Railroad
Roy Creath, Union Pacific Railroad

5 kHz Issues in Refarming

I. Introduction

The Federal Communications Commission has been promoting the use of Very Narrow Band (VNB) technologies as a solution to congestion since the beginning of the refarming era. The VNB channel width has been stated to be either 5 kHz or 6.25 kHz for the VHF and UHF bands respectively.

From user's perspective, the only attraction that VNB offers is the promise of reducing congestion through the creation of more channels in the same amount of spectrum. Users, however still demand equivalent or better service quality and functionality, regardless of the technology implemented. The purpose of this document is to review the issues of opposition to 5 kHz, VNB channelization.

II. Current 5 kHz technology issues

A. Current systems require repeater operations to ensure stability.

The equipment being sold for operations in the 220 MHz band must operate in a repeater mode in order for the mobile to remain within the channel mask. This creates an inherently inefficient use of the spectrum when considering that a total of 10 kHz of spectrum is consumed to support one voice conversation.

Technological advancement will improve the availability of more stable oscillators which will eliminate the need for repeater operations. However, it is not clear if the users of the 220 MHz band will be required to become more efficient by supporting two conversations in one paired 5 kHz channel assignment.

B. Current linear modulation systems require an advancement in battery technology for portable radio operations.

Linear modulation techniques require that the transmitter be capable of operating in a mode which requires power consumption that exceeds current FM transmitter characteristics. Typically, this is not an issue for base stations due to the availability of commercial power. However, for mountain top solar powered sites, power consumption is of great importance.

Portable radios are the most common concern of additional power consumption rates. Users require that a portable radio should last a minimum of 8 hours between charging cycles under typical usage conditions. They also require that the battery size not be any larger or heavier than current designs. This requires manufacturers to develop a new technology to derive more energy from the same physical space and mass similar to that of the current batteries.

III. Data transmission considerations.

A. Data communications is mandatory for future system designs.

With the proliferation of personal data devices such as lap top PCs and hand held data terminals, data communications must be included in every system design of the future. Along with the requirement of data communications comes the requirement of channel capacity and data throughput.

B. There are tradeoffs in performance and coverage when forcing channel capacity beyond theoretical limits.

Channel capacity theory, by Shannon, states that under standard conditions, there is a finite amount of information which can be sent through a channel having a specific bandwidth. If additional capacity is required, a technique must be employed which will improve the effective signal to noise ratio (S/N) of the channel. Techniques such as increasing transmitter power or receiver sensitivity, reducing the distance between transmitter and receiver, encoding, or forward error correction are required to achieve additional capacity.

C. Typical VNB data channel rate is 2400 bps, with 19.2 kbps achievable through high level modulation techniques.

Current technology can provide reliable and robust data transmission in a VNB channel at a rate of 2400 to 4800 bps. There have been claims of achieving channel rates of 9.6 kbps to 19.2 kbps in a VNB channel by using 16 QAM modulation.

Research on 16 QAM has shown that the transmission environment has to be very stable in terms of high signal to noise ratios. This is necessary so that an adequate S/N can be reached to demodulate the vector amplitude variations associated with the QAM technique. One current design for 16 QAM VNB system utilizes electronic "steerable" yagi antennas. Without using this technique, additional sites will be required to provide acceptable field strengths in order to reliably recover the transmitted information.

D. True data communications should not be confused with facsimile transmissions.

Some VNB equipment suppliers consider data transmission to be in the form of fax type modem operations. Fax transmissions are more tolerant of impulse noise on a transmission channel. Digitized voice and video are also much more tolerant of interference caused by noise spikes than true data transmissions.

In the case of noncompressed digitized video and voice as well as in fax transmissions, missing data bits can be over looked to some extent. They often are translated into noise spots on faxes and in videos or as an audible noise in reassembled digital voice.

Actual data transmission requires that every bit sent must be either received or recreated in order to know the message content. When utilizing data compression techniques, each bit represents more data and therefore becomes vital to the reconstruction of the transmitted message.

IV. General Concerns

A. Real world, major metropolitan VNB implementation is not fully understood.

The current channel plan for VNB creates a channel density which has not been fully evaluated as of yet. As transmitter carrier frequencies get closer together, Inter Modulation (IM) products increase. As IM increases, effective receiver sensitivity decreases, thus placing more demand on the radio system to provide enhanced signal quality. Also, the latest analysis indicates that the IM products increase at a nonlinear rate as channel centers move closer together.

B. Migration of the VNB equipment into overly congested areas is difficult.

The VHF band is currently highly congested. Many tests need to be conducted to determine how resistant the VNB linear technologies are to cochannel and adjacent channel interference. This information is necessary in order to determine to what extent a geographical area needs to be cleared prior to the implementation of the VNB systems.

It appears as though the only method available to migrate from the current systems to the VNB technologies is to utilize dual mode radios. Many users feel that this is not acceptable due to the fact that mobile operators can be "lost" if they are not careful with setting the mode selector.

C. A 5 kHz VNB channel plan will preclude the technology and associated equipment from several major manufacturers.

Several major manufacturers planning to provide APCO 25 radios will not be able to sell their 6.25 kHz equipment. Manufacturers offering TDMA based equipment will also not be able to sell their equipment which requires a minimum channel width of 12.5 kHz. Channel stacking is one solution for the creation of additional bandwidths. The technique for accomplishing this is not clear when attempting to stack channels in noncontiguous, congested service pools. Also, manufacturers need to evaluate the ability of radio equipment to operate on a nonstandard channel center which occurs in the middle of combined channels.

V. Summary Comments

The Commission should not perceive the private radio users' resistance to moving to 5 kHz technologies as a resistance to changing with technology. Nor should the Commission feel that the private radio users do not wish to be efficient with spectrum usage. On the contrary, all major users of the private radio spectrum rely heavily on the advancement of technology and realize that spectrum is a scarce commodity.

The issue is that the radio systems employed by the private radio users perform vital functions on a day to day basis. Those functions can be as simple as dispatching a pizza delivery vehicle or as complicated as providing a communications link for critical statistics of a patient in route to a hospital.

A major concern within the private radio community is that before the old technology can be abandoned, nearly all possible shortcomings of the new technology must be known. With the knowledge of a technology's limitations, new technology can be employed to enhance an inadequate system to the point of being robust and reliable.

As an example, the 16 QAM systems will perform well in low noise environments. Unfortunately, the low noise environments are typically located in the rural areas where spectrum congestion is not an issue. In the major metro areas where the congestion is the worst, the noise floor is typically much higher. For those areas, an advancement in spectral noise reduction and cancellation technology is necessary to make a 16 QAM system a viable communications solution.

The Commission is being respectfully asked to carefully evaluate the shortcomings of new technologies. The fact that a new technology is feasible does not necessarily indicate that it is the "best fit" communications technique. This is most evident when the technology is implemented in a highly congested metropolitan area.

For each private radio user, radio communication for their businesses is very important to their ability to do business. Otherwise the private radio system owners would never have invested in the radio systems to begin with.

In turn, the Nation's economy is highly dependent on healthy businesses. Impairing a core function of businesses through impacting the private radio systems will, ultimately, have a negative effect on the Nation's economy.